United States Department of Agriculture

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Utah Manure Application Risk Index (UMARI)

UMARI, October, 2000

A PROCEDURE FOR DETERMINING BEST MANAGEMENT PRACTICES FOR SPREADING OF MANURE ON AGRICULTURAL LANDS IN UTAH, THE UTAH MANURE APPLICATION RISK INDEX (UMARI)

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Manure and Utah Agriculture

Manure is an important resource for Utah livestock farmers and ranchers. Too often, however, it is treated as a waste rather than a resource. Treated properly, manure can supply all the nitrogen (N) and phosphorus (P) needs of a crop.

Many rivers, streams, and lakes in Utah have levels of P and in a few cases N that exceed designated water quality standards. These high nutrient levels are in part due to improper application of manure on agricultural lands. When manure is applied to land as a waste rather than a resource, there can be a high potential to pollute both surface and ground water with P, N, pathogens, and organic matter. This occurs particularly if manure is applied inappropriately on fields too close to a waterbody, on land that is frozen or snow covered, when applied in excessive amounts, or when other proper land management practices are not in place.

Manure collection, storage and treatment can be very costly. Daily hauling and spreading is generally considered the least costly method for handling manure by many Utah livestock operations, but suitable spreading sites are not always available on a daily basis. Spreading of manure during the winter reduces the need for manure storage, but may also contribute to non-point source pollution. Decisions regarding manure application rate, timing, and placement can not always be made during the winter in a manner that does not contribute to pollution. Improper application of manure during the spring, summer, or fall months, as well as timing of application and improper land management practices (e.g. poor irrigation practices or not incorporating the manure after application) can also contribute to pollution.

Long term field research with soil and crop management systems in Utah has been used to determine the amount of fertilizer or manure needed to obtain maximum economic crop yields. The Utah Fertilizer Guide (EC431) written by fertility specialists from Utah State University provides guidance on the amount of nutrients to add to obtain desired crop yields. Over the years, various University researchers have determined the effectiveness of manure application rate, timing and placement, and crop nutrient uptake values. This research provides a basis for best management practices for manure application in Utah.

Soil testing is the best method to determine the amount of plant available nutrients in the soil. The Utah State University Soil Testing Laboratory uses agronomic soil test levels as the basis for nutrient recommendations for Utah crops.

Manure nutrient levels in Utah are highly variable depending on the livestock type, storage facility, moisture content, and the amount and type of bedding in the manure. Testing can identify the amount of plant available nutrients in manure. Manure tests should be taken for several years in order to obtain average nutrient values for given conditions. In the absence of manure test data, estimates can be made using procedure as outlined in the Natural Resources Conservation Service (NRCS) Agricultural

Waste Management Field Handbook. This information has been computerized and can be obtained through NRCS. Two different programs are currently available. The first is the Animal Manure Nutrient Balance Version 2.4 Excel Spreadsheet. The second was modified from the Ohio Animal Waste Management Software and is titled Animal Waste Management Version UT-2.22.2, December 1997. These programs can be used to estimate the tons of manure and pounds of N and P generated by an animal feedlot operation.

Manure and the Environment

Water quality concerns with manure involve nitrogen, phosphorus, pathogens, and organic material. Phosphorus is generally the greatest concern in Utah. Phosphorus from manure, contained in runoff or sediment that reaches surface water can cause **eutrophication** *(defined as an increase in the fertility status of natural waters that causes accelerated growth of algae or water plants.)* In most surface waters (streams, lakes, etc.), the growth of algae or aquatic plants is limited by inadequate levels of P. Large inputs of P to surface water from non-point sources such as agricultural fields through erosion or runoff can induce eutrophic conditions. This is particularly true if the soils in the field have elevated levels of P due to excessive manure applications. Point sources of P, such as discharge from barn wash water, waste water treatment plants, septic systems, or even direct residential effluent can also contribute to eutrophication.

Utah State University has promoted fertilizing to meet realistic and economic yield goals with adequate phosphorus. However, some counties in Utah now have a high number of soils testing high or very high in P, particularly on fields that receive manure annually. Tests have shown levels as high as 400 ppm available P (Olsen) on these fields. These soil P levels are high enough to supply crop phosphorus needs for 10 or more years without any additional nutrient applications. At this level, it is necessary to stop applying all sources of phosphorus, including manure applications.

Daily spreading of manure, improper application of manure, and poor land management practices can contribute to non-point source pollution of surface and ground water. The challenge is to develop a plan to utilize the nutrients in manure and at the same time maintain agricultural profitability and environmental quality. The **Utah Manure Application Risk Index** provides a procedure for assessing site-specific features; manure application and land management practices that influence runoff and leaching of nutrients, pathogens, and organic matter.

The Utah Manure Application Risk Index

The Utah Manure Application Risk Index is an evaluation tool that can be used to identify site-specific features, manure application practices and land management practices that contribute to runoff and leaching losses of P and N. It also provides a method to characterize the effectiveness of best management practices on reducing the risk of runoff and leaching. It is also used as a planning tool for developing resource management systems, comprehensive nutrient management plans, and ecosystem based watershed planning. The tool provides a format in which information about nutrient movement in the landscape and best management practices can be conveyed to the land user.

Many states prohibit application of manure on frozen/snow covered ground, regardless of the risk. UMARI provides a method of assessing the risk of winter application, thus allowing application on sites where the potential risk of nutrient runoff and leaching is low and prohibiting application where the risk is high.

Where manure production exceeds land availability, the index can be used to evaluate the potential for spreading manure on other farms. A cooperative agreement with other landowners that assures there is sufficient land to properly utilize the manure may be necessary to avoid build up of high soil phosphorus levels. The index can also be used to reduce manure storage needs based on the availability of land where manure can be spread during the winter at low risk to the environment.

The index is divided into two sections. The first section contains management practices and site-specific features related to winter application of manure. The second section contains management practices and site-specific features related to spring, summer, and fall application of manure.

The index uses various field features (Refer to Tables 1 & 2) for making the evaluation. Each feature is associated with a risk for nutrients to be transported on the landscape. The index assigns an individual numerical rating for winter application of manure to: the distance to water, irrigation type/field surface, cover type, runoff containment, the depth of soil limitations, the soil hydrologic group, field slope, adjusted available water holding capacity, and winter precipitation. The index also assigns an individual rating for spring, summer, and fall application of manure to: the distance to water, irrigation type/field surface, cover type, incorporation of manure, the depth of soil limitations, the soil hydrologic group, field slope, runoff control, and irrigation efficiency.

By implementing appropriate conservation and best management practices an individual fields' numerical rating can be altered. For example, installing buffer areas, establishing application setbacks, or improving the irrigation system can lower the numerical rating and therefore the risk of pollution. By evaluating specific features on each field, this assessment method can identify the location and areas where the potential risk of runoff and leaching is low or high. Areas of high risk can then be addressed as necessary.

Using the Utah Manure Application Risk Index

The Index assumes that manure is applied at appropriate application rates for either N or P, based on NRCS Nutrient Management standard 590. This standard requires both soil and manure testing to determine proper application rates, as well as threshold soil test phosphorus values. Threshold values determine the point at which soil phosphorus levels have become so high that applications must be based on crop phosphorus needs or should not be made at all.

The index uses nine factors to obtain a rating for winter application (Table 1) of manure and nine factors to obtain a rating for spring, summer, and fall application (Table 2) of manure on any given site. The nine factors for spreading of manure during the winter are:

1) Distance to water *(This factor is determined by measuring the distance of the downstream edge of the field from live water or an irrigation ditch that conveys water to a stream, lake, pond, or other water body. Application setbacks and vegetative buffers can be used to lower this rating.)*

2) ***Irrigation Type/Field Surface*** *(This factor is determined by the type of irrigation system as well as the condition of the field surface. This rating can be lowered by changing the type of irrigation system or by making improvements to the condition of the field in such a way as to reduce the risk of nutrient movement from the field.)*

3) ***Cover Type*** *(The type of cover on a field during the winter can influence the amount of runoff that occurs when snow melts. The greater cover, the less the runoff. This rating can be improved by changing the type of cover on the field.)*

4) ***Runoff Containment*** *(In some cases, manure can flow directly into surface waters or onto neighboring property, both of which are a violation of state law. In these cases, runoff can be contained so that manure does not flow into a water body or onto neighboring property. Where manure flows into adjacently owned fields or into an internal irrigation distribution system, the risk for pollution would be much lower.)*

5) ***Soil Limitations for Leaching*** *(The risk of leaching of nutrients is higher where a water table exists and may also be high where the depth to bedrock is shallow or where the soils within the rooting depth of* *the crop are gravelly or sandy. Only changing the amount of manure that is applied can change the risk. Where a soil limitation is present at less than or equal to a 2-foot depth, manure should not to be applied when the soil is frozen, snow covered or saturated. When applied during the spring, summer, or fall manure should be applied based on crop agronomic uptake rates for phosphorus.)*

6) ***Hydrologic Soil Group*** *(NRCS soil surveys categorize soils as group A, B, C, or D. Hydrologic soil groups are based on soil texture and permeability and relate to the tendency for water to runoff from the given soil. Group A soils have low runoff characteristics while D soils have high potential runoff characteristics. The soil map unit that is nearest to the water source, that is most restrictive, or that is the dominant soil should be used for the evaluation when more than one soil map unit exists in the field.)*

7) ***Slope*** *(Slope has a large impact on runoff from melting snow and irrigation water. Generally, the greater the slope the greater the tendency for water to run off a field. This is particularly applicable on fields that have guide furrows, corrugations, or other areas of concentrated flow.)*

8) ***Adjusted Available Water Holding Capacity – Adj. AWC*** *(This factor accounts for the ability of a soil to capture runoff and to prevent leaching losses. Heavier clay soils hold larger amounts of water while sandy soils hold less water. The AWC is based on a five foot rooting depth or the depth to any soil limitations. This factor requires that an adjustment be made to the estimated average soil moisture going into the winter. It is calculated by multiplying the AWC times 75%. This factor allows for the landowner to modify irrigation and cropping practices to provide for application of manure on fields that go into the winter dry rather than wet.*)

9) ***Winter Precipitation*** *(Most of the winter precipitation in Utah comes in the form of snow during the winter. The amount of winter precipitation varies greatly throughout Utah. The valley floor areas may receive as little as 2 inches of winter precipitation whereas the mountain valleys may receive up to 10 inches. Generally, the greater the amount of winter precipitation, the greater the potential for runoff and leaching. This factor relates the amount of winter precipitation to the amount of water that the soil will hold. This factor is calculated as a summation of precipitation values from mid October thru mid March.)*

Several factors already described have similar effects on movement of nutrients from manure applied during the spring, summer, and fall. These factors include: distance to water, irrigation type/field surface, cover type, soil limitation, hydrologic group, and slope, and are interpreted the same as for winter application. In addition, incorporation of manure, runoff control, and irrigation water efficiency, are important factors to consider when spring, summer, and fall applications are made:

1) ***Incorporation*** *(Manure that is left on the surface has greater potential to run off when irrigation water is applied. It also effects the volatilization of nitrogen. The longer the manure is left on the surface the more volatilization occurs thus reducing the amount of nitrogen available for crop growth. Incorporating manure within the top four inches of soil immediately after application will lower volatilization losses as well as the potential for runoff.)*

2) ***Runoff Control*** *(This factor is almost the same as the factor in the winter application parameters. It incorporates the use of tailwater recovery systems and wetlands rather than full containment at the very low and low risk levels.)*

3) ***Irrigation Efficiency*** *(The type of irrigation system generally controls the efficiency of water application; however, highly efficient but improperly managed systems can still*

have low efficiencies. This factor looks at the efficiency of the system as managed. Managing the irrigation system for the highest possible efficiency can lower the risk of pollution.)

Each field feature is assigned a risk level of **VERY LOW, LOW, MEDIUM** or **HIGH** based on the relationship between the feature and the potential for manure or nutrient loss from the site. Each feature is also assigned an appropriate point value for the risk level. Not all field features are assigned the same point value. For example, distance to water is assigned values that range from 1.5 to 9 points, while AWC is assigned values from 0.5 to 3 points.

Currently, the risk levels and point values are based on the professional judgment of the authors of the index. Past and current research verify the concepts behind the risk index and have demonstrated the effectiveness, value, and benefits of best management practices. Over time it is expected that the accuracy of the risk levels and point values will be verified by additional research and refined as necessary.

The index is designed, mainly, to capture the factors that influence runoff. Some of the factors conflict with leaching. For example, hydrologic group A soils are generally sandy soils and have a low risk for runoff but a high risk for leaching. This is offset, however, by a high risk rating for available water holding capacity. The overall effect of the index, after best management practices have been implemented, will be a reduction in leaching.

Calculating the Manure Risk Index

A copy of the Index is found at the end of this section. The Risk Index Worksheet along with the associated tables is used in conjunction with a field visit on each site. The visit should be made, preferably, when the farmer or farm manager is present. The assessment will assist in determining land suitability for manure spreading as well as conservation and management practices that can be used to reduce the risk of runoff and leaching of manure applied on irrigated ground. The index also serves as a guide to determine when practices, such as filter strips, application setbacks, improvement in the field irrigation system, incorporation of manure, etc. should be implemented.

The worksheet is to be used in the following manner: From information gathered in the field, select a point value for each field feature from one of the four risk levels**: VERY LOW, LOW, MEDIUM,** or **HIGH.** Sum the point values for all appropriate field features to determine the Manure Application Risk Index for the field. Winter values are summed separately from spring, summer, and fall application values. Compare the Manure Index with Table 4 to categorize the field vulnerability for manure loss. Then, if necessary, determine appropriate management practices (Table 5) for the site. Finally, reevaluate the site to determine the effect of the selected best management practices on the risk level.

The following example (shown in the picture) illustrates how the **Manure Application Risk Index** should be used:

Example Calculation:

Field Feature	**Point value**
Winter Application:	
Distance to water Field edge adjacent to water	9.0
Irrigation Type/Field Surface Flood irrigation w/out furrows	6.0
Cover Type Bare ground	9.0

Runoff Containment	9.0
Flows directly to water	
Soil Limitations	1.5
None	
Hydrologic Group	3.0
Group B	
Slope	3.0
2-3%	
Adjusted AWC	2.0
Adjusted equals 7.2”	
Winter Precipitation	1.0
0-2” over Adj. AWC	
Total Point Value (Risk Index)	43.5

Spring, Summer, Fall Application:

Distance to Water	9.0
Field edge adjacent to water	
Irrigation Type/Field Surface	6.0
Flood irrigation w/out furrows	
Cover Type	9.0
Bare ground	
Incorporation	9.0
Not incorporated	
Soil Limitations	1.5
None	
Hydrologic group	3.0
Group B	
% Slope	3.0
2-3%	
Runoff Control	3.0
Flows directly to water	
Irrigation Efficiency	2.0
Efficiency 45%	
Total Point Value (Risk Index)	45.5

Both the winter index and spring, summer, and fall index show for this field that the risk of pollution is MEDIUM (Table 4). Implementation of buffer strips along the edge of the ditch, application setbacks, or other practices may reduce the risk of pollution. Implementation of the suggested management practices would have the following impact on the Manure Application Risk Index:

Field Feature	**Point value**

Winter Application:

Distance to water	6.0
Appropriate setback applied	
Irrigation Type/Field Surface	6.0
Flood irrigation w/out furrows	
Cover Type	3.0
Grain Stubble	
Runoff Containment	1.5
Fully contained	
Soil Limitations	1.5
None	
Hydrologic Group	3.0
Group B	
% Slope	3.0
2-3%	
Adjusted AWC	2.0
Adjusted equals 7.2”	
Winter Precipitation	1.0
0-2” over Adj. AWC	
Total Point Value (Risk Index)	27.0

Spring, Summer, Fall Application:

Distance to Water	6.0
Appropriate setback applied	
Irrigation Type/Field Surface	6.0
Flood irrigation w/out furrows	
Cover Type	3.0
Plowed ground	
Incorporation	1.5
Incorporated at time of application	
Soil Limitations	1.5
None	
Hydrologic group	3.0
Group B	
% Slope	3.0
2-3%	
Runoff Control	3.0
Flows directly to water	
Irrigation Efficiency	1.0
Efficiency 50%	
Total Point Value (Risk Index)	28.0

Reevaluation of Application Risk Index:

The Winter Application Risk Index for this field is now LOW. The potential for runoff or leaching to occur is within an acceptable range after putting in place an appropriate setback, containing all runoff, and changing the cover type to which the manure is applied. The Spring, Summer, and Fall Application Risk Index is also LOW. The potential for runoff and leaching is within an acceptable range after putting in place an appropriate setback, changing the cover that manure is applied to, incorporating the manure when applied, and improving irrigation efficiency. Note that by applying these practices the Winter Application Risk Index was lowered from MEDIUM (43.5) to LOW (27.0) and the Spring, Summer, Fall Application Risk Index was lowered from MEDIUM (45.5) to LOW (28.0).

*Utah Manure Application Risk Index - Worksheet

Landowner: ____________________ **Weather Station:** ____________________
Planner: ____________________ **Location:** ____________________
Winter Precipitation: __________ **(Table 3)** **Date:** ________________

Tract:								
Field:								
Soil Symbol:								
Adj. AWC:								

Section 1: Winter Application Parameters

Distance								
Irr. Type								
Cover Type								
Containment								
Soil Limit.								
Hyd. Group								
% Slope								
Adj. AWC								
Winter Precip.								

Total Points:								
Risk Level:								
Practices to be Implemented								

Section 2: Spring, Summer Fall Application Parameters

Distance								
Irr. Type								
Cover Type								
Incorporation								
Soil Limit.								
Hyd. Group								
% Slope								
Runoff Ctrl.								
Irr. Efficiency								

Total Points:								
Risk Level:								
Practices to be Implemented								

*Any individual features with a High rating should be evaluated and conservation practices applied where possible. Where a soil limitation is present at ≤ 2 feet, manure should not be applied on frozen/snow covered ground nor at levels above the agronomic rate for phosphorus.

Practices to be Implemented:

CT = Cover Type
FS = Filter Strip
IN = Incorporation
SB = Setback
IS = Irrigation System Improvement
IWM = Irrigation Water Management
SM = Soil Moisture Management
TR = Tailwater Recovery System
RB = Riparian Buffer
RC = Runoff Containment
SL = Soil Limitation
WS = Wetland System

Table 1

*Winter Application Parameters**

Field Features	Very Low Risk	Low Risk	Medium Risk	High Risk**
Points:	**1.5**	**3**	**6**	**9**
Distance to Water	> 1000 feet from water or ditch	500-1000 feet from water or ditch	Appropriate setback applied[1] (< 500 feet)	Downstream edge of field adjacent to water or ditch
IrrigationType/ Field Surface	Sprinkler, level border, smooth level field	Graded border, flood irrigation w/out furrows	Flood irrigation with furrows, rolling surface	Uncontrolled flood, unlevel, hummocky
Cover Type	Good stands of alfalfa, grass, or a cover crop	Grain stubble, plowed, or rough bare ground	Corn stubble, or poor stands of perennial crops	Smooth, bare ground
Runoff Containment	Fully contained for a 10 year 24 hour storm size	Flows into adjacently owned field	Flows into internal field distribution ditch	Flows directly to water or off owned property
Soil Limitations[2]	> 5 ft	4-5 ft	2-4 ft	≤ 2 ft
Hydrologic Group[3]	A	B	C	D
% Slope	< 2%	2-3%	4-5%	> 5%
Points:	**0.5**	**1**	**2**	**3**
Adjusted AWC[4]	> 10"	7.5-10"	2.5-7.5"	< 2.5"
Winter Precipitation (Oct. to Mar.)	< Adjusted AWC	0 to 2" over Adjusted AWC	2-3" over Adjusted AWC	> 3" over Adjusted AWC

*Applicable only to irrigated lands. Refer to field feature definitions.
** Individual high-risk features should be evaluated and conservation practices applied where possible.

1. Manure is applied according to an appropriate setback as shown in the following table. Where vegetative buffers such as filter strips or riparian buffers are applied, setback distances may be lowered as shown in the table. Setback distances shown are from the edge of the field when buffers are not used or from the edge of the buffer.

	Setback Distance w/out Buffers (ft)		**Setback Distance with Buffers (ft)**	
% Slope	**Without Furrows**	**With Furrows**	**Without Furrows**	**With Furrows**
0-1	50	100	0	10
1-2	150	200	10	20
2-3	250	300	20	30
3-4	350	400	30	40
4-5	450	500	40	50

2. Soil limitations include water table, bedrock, and gravelly or coarse sandy layers in the rooting depth.
3. Use the soil map unit that is nearest to the water source, that is most restrictive, or that is the dominant soil where more than one soil map unit exists in the field.
4. Multiply the available water holding capacity for a 5-ft depth or for the depth of the soil limitation by 75%.

Table 2

*Spring, Summer, Fall Application Parameters**

Field Features	Very Low Risk	Low Risk	Medium Risk	High Risk**
Points:	**1.5**	**3**	**6**	**9**
Distance to Water	> 1000 feet from water or ditch	500-1000 feet from water or ditch	Appropriate setback applied[1] (< 500 feet)	Downstream edge of field adjacent to water or ditch
IrrigationType/ Field Surface	Sprinkler, level border, smooth level field	Graded border, flood irrigation w/out furrows	Flood irrigation with furrows, rolling surface	Uncontrolled flood, unlevel, hummocky
Cover Type	Good stands of alfalfa, grass, or a cover crop	Grain stubble, plowed, or rough bare ground	Corn stubble, or poor stands of perennial crops	Smooth, bare ground
Incorporation of Manure	Injected or incorporated at time of application	Incorporated w/in 7 days by tillage or irrigation	Incorporated w/in 3 months by tillage or irrigation	Not incorporated, or incorporated after 3 months
Soil Limitations[2]	> 5 ft	4-5 ft	2-4 ft	≤ 2 ft
Hydrologic Group[3]	A	B	C	D
% Slope	< 2%	2-3%	4-5%	> 5%
Points:	**0.5**	**1**	**2**	**3**
Runoff Control	No runoff, or tailwater recovery system in place	Flows into a semi-isolated wetland area	Flows, unregulated, into internal field distribution ditch	Flows directly to water or off owned property
Irrig. Efficiency	> 60%	50-60%	40-50%	< 40%

*Applicable only to irrigated lands. Refer to field feature definitions.
** Individual high-risk features should be evaluated and conservation practices applied where possible.

1. Manure is applied according to an appropriate setback as shown in the following table, filter strips or riparian buffers are used, or manure is incorporated within 7 days after application. Incorporation must be done by tillage, sprinkler, or border irrigation only. Setback distances are from the edge of the field when buffers are not used or from the edge of the buffer.

	Setback Distance w/out Buffers (ft)				**Setback Distance with Buffers (ft)**			
	w/incorporation		**w/out incorp.**		**w/incorporation**		**w/out incorp.**	
% Slope	**Sprink.**	**Flood**	**Sprink.**	**Flood**	**Sprink.**	**Flood**	**Sprink.**	**Flood**
0-1	10	20	20	40	0	5	5	10
1-2	20	40	40	80	5	10	10	20
2-3	30	60	60	120	10	15	15	30
3-4	40	80	80	160	15	20	20	40
4-5	50	100	100	200	20	25	25	50

2. Soil limitations include water table, bedrock, and gravelly or sandy layers in the rooting depth.
3. Use the soil map unit that is nearest to the water source, that is most restrictive, or that is the dominant soil where more than one soil map unit exists in the field.

Table 3

Winter Precipitation Values (From the Utah Climate Handbook)

Station	Jan	Feb	*Mar	*Oct	Nov	Dec	Total
Altamont	0.70	0.69	0.39	0.47	0.59	0.82	**3.7**
Bear River Bay Refuge	1.15	0.92	0.55	0.62	1.08	1.08	**5.4**
Beaver	0.81	0.87	0.51	0.41	0.87	0.85	**4.3**
Brigham City	2.23	1.54	0.98	0.77	2.12	2.10	**9.7**
Castle Dale	0.56	0.48	0.28	0.37	0.48	0.52	**2.7**
Cedar City Airport	0.69	0.89	0.68	0.48	1.00	0.70	**4.4**
Circleville	0.50	0.46	0.36	0.35	0.58	0.59	**2.8**
Coalville	1.08	1.12	0.77	0.76	1.59	1.27	**6.6**
Corinne	1.42	1.56	0.80	0.82	1.59	1.55	**7.7**
Cutler Dam	1.08	1.46	0.94	0.93	1.96	1.37	**7.7**
Delta	0.49	0.56	0.43	0.41	0.70	0.62	**3.2**
Duchesne	0.43	0.50	0.32	0.47	0.52	0.73	**3.0**
Elberta	0.81	0.86	0.51	0.54	0.92	0.86	**4.5**
Ft. Duchesne	0.33	0.34	0.24	0.44	0.37	0.47	**2.2**
Fairview	0.82	1.14	0.79	0.53	1.24	0.92	**5.4**
Grantsville	0.62	0.80	0.65	0.56	0.97	0.89	**4.5**
Heber	1.78	1.56	0.69	0.73	1.64	1.62	**8.0**
Huntsville	1.92	2.08	1.10	0.94	2.47	1.92	**10.4**
Jensen	0.46	0.52	0.31	0.51	0.59	0.63	**3.0**
Kamas 3 NW	1.45	1.74	0.81	0.85	1.61	1.53	**8.0**
Kanosh	1.12	1.17	0.97	0.65	1.36	1.36	**6.6**
Lapoint	0.66	0.41	0.29	0.52	0.68	0.66	**3.2**
Logan 5 SW Exp. Farm	1.43	1.59	0.89	0.95	1.75	1.51	**8.1**
Logan Experiment Sta.	1.58	1.28	0.82	0.72	1.45	1.54	**7.4**
Logan Radio	1.02	1.27	0.81	0.82	1.46	1.29	**6.7**
Logan USU	1.40	1.65	1.01	0.94	1.73	1.72	**8.5**
Milford	0.67	0.67	0.52	0.40	0.73	0.72	**3.7**
Minersville	0.78	0.84	0.74	0.50	0.88	0.89	**4.6**
Morgan	1.84	1.88	0.93	0.85	1.98	1.97	**9.4**
Moroni	0.85	0.82	0.48	0.46	0.86	0.93	**4.4**
Ogden Sugar Factory	1.31	1.29	0.83	0.78	1.59	1.35	**7.1**
Randolph	0.28	0.57	0.33	0.45	1.05	0.48	**3.2**
Richfield Radio	0.56	0.58	0.37	0.42	0.67	0.59	**3.2**
Richmond	1.46	1.53	0.99	0.92	1.72	1.68	**8.3**
Riverdale	1.51	1.57	1.08	0.93	1.69	1.62	**8.4**
Riverton	0.81	0.94	0.69	0.39	0.76	1.47	**5.1**
Spanish Fork 1 S	1.70	1.35	0.65	0.39	1.22	1.42	**6.7**
Tremonton	1.06	1.19	0.92	0.91	1.54	1.31	**6.9**
Trenton/Lewiston	1.38	1.50	0.83	0.84	1.61	1.45	**7.6**

*½ avg. monthly precipitation

Field Feature Definitions

Adjusted AWC – Available water holding capacity refers to the ability of a soil to hold water. It is expressed in inches of water per inch or foot of soil depth or as a percent. For the purposes of this tool, AWC is based on a 5-foot depth or the depth to an identified soil limitation. The AWC is then multiplied by 75% to obtain the adjusted AWC. The adjustment accounts for average soil moisture at the end of the irrigation season. (NRCS-Utah Irrigation Guide, determined by on site visit or farmer interview)

Appropriate Setback - The distance from the field edge when buffers are not used or from the edge of the vegetative buffer. Setbacks are applicable on fields that are adjacent to a stream or other surface water body receiving runoff from the field, on fields with ditches that feed into a stream or water body, and on areas where concentrated flow occurs. (determined by on site visit)

Areas of Concentrated Flow – Areas where there is a concentrated flow of surface runoff when it rains or when snow melts. The flow generally travels through a waterway or ephemeral gully and eventually enters a surface waterbody. (determined by on site visit)

Cover Type/Residues - Over winter cover depends on tillage method, manure type, remaining crop residue, cover crops, CRP cover, alfalfa or pasture in field, or condition of the soil surface. Vegetative cover or rough soil conditions will reduce runoff depending on kind, amount, and condition. (determined by on site visit or farmer interview)

Incorporation of Manure - How the manure is applied to the land and incorporated. Incorporation methods include immediate injection or incorporation at the time of application, surface application and incorporation four inches deep within 7 days or 3 months, or surface application with no incorporation. (determined by on site visit or farmer interview)

Irrigation Efficiency – The amount of irrigation water applied to a field in relation to the amount of water needed for crop use and evaporation losses. (obtained from NRCS-Utah Irrigation Guide, Farm Irrigation Rating Index, or calculated from irrigation information)

Irrigation Type/Field Surface – Type of system used to irrigate the field. Generally, the type of system influences the surface condition. Smooth level fields will have less runoff than unlevel, furrowed fields.

Manure Application Rate - Based on the type, amount and kind of manure, the amount of P in pounds per acre and the amount of N in pounds per acre. (determined from on site manure application information)

Percent Slope - Average percent slope of the field landscape. (NRCS-Soil Survey or determined by on site visit)

Runoff Containment – A system of berms, dikes, channels, diversions, or a return flow system which keeps water from leaving the owners property. Water is contained for a 10 year 24 hour storm event. (determined by a qualified engineer)

Runoff Control – A tailwater recovery system or wetland system is in place. The wetland may be isolated or semi-isolated from entering another water source. (NRCS-FOTG Section IV Standards for wetlands and tailwater recovery)

Soil Hydrologic Group - A group of soils having similar runoff potential under similar storm and cover conditions. (NRCS FOTG Section II, Soils Database or NRCS EFM, Chapter 2, Soil Survey)

Soil Limitations – Soil limitations include water table, bedrock, and gravelly or sandy layers within the rooting depth. (NRCS Soil Survey or on-site investigation)

Vegetative Buffers - Strips or small areas of land in permanent vegetation that help control potential pollutants and manage other environmental concerns. Filter strips, field borders, grassed waterways/vegetative filters, shelter belts, and riparian buffers are all examples of vegetative buffers. (NRCS-FOTG Section IV Standards for the various buffer practices)

Winter Precipitation – The average amount of precipitation that occurs from mid October to mid March obtained from the Utah Climate Handbook. (Table 3)

Table 4

Utah Manure Application Risk Index
Field Vulnerability for Manure Loss

Manure Application Risk Index	**General Interpretation of Utah Manure Application Risk Index**
< 16	**VERY LOW** potential for manure movement from the field. If manure is managed properly, there is little or no probability of an adverse impact to surface or ground water. These fields have very good potential for year round spreading.
16 – 32	**LOW** potential for manure movement from the field. The chance of organic material and nutrients' getting into surface or groundwater is small. Buffers, setbacks, improved irrigation and manure application practices, runoff containment/control alone or in combination will reduce impact. These fields have good potential for year round spreading, provided best management practices are in place.
33 – 48	**MEDIUM** potential for manure movement from the field. The chance of organic material and nutrients getting to surface or ground water is very likely. A combination of buffers, setbacks, improved irrigation practices, and/or application practices, will lower the impact. These fields have very limited or no potential for winter spreading.
> 48	**HIGH** potential for manure movement from the field and an adverse impact on surface and ground water. Manure should not be applied unless best management practices are in place. Manure should not be spread during the winter.

Manure Management Options Based on the Manure Application Risk Index

Minimizing non-point source pollution of surface waters from manure applied to cropland, hayland and pastureland requires management practices that control both the supply and transport of manure solids and liquids. The basic objectives of environmentally sound manure management practices are to maintain good soil health; utilize the nutrients available from manure; recycle N and P through the crops; and store nutrients in the soil for later use by the next crop. Determining the Application Risk Index for individual fields is the first step in this process because the index points out the best management practices needed to develop manure utilization plans that minimize runoff and leaching. Trapping soil, manure, and water that is enriched with nutrients and pathogens is best accomplished with containment, cover type management, and vegetative buffers. Buffers are most beneficial adjacent to streams for trapping nutrient-rich sediments or organic material and protecting surface water quality. Implementing practices such as: soil and manure testing, application setbacks, and evaluating winter spreading on lower risk fields all reduce the risk of impact to the environment. The higher the initial Manure Application Risk Index the greater the necessity to select practices that will reduce the risk. *Manure management requires very site specific planning,* and a well-planned and coordinated effort between farmers, crop advisors, soil conservationists, and other nutrient management planners.

Table 5

Management Options to Minimize Non-Point Source Pollution of Surface and Ground Water by Manure

Application Setbacks – Where water from irrigation or snowmelt will enter a water body or a ditch that ends up in a water body, do not apply manure next to the field edge. The distance of the setback is determined by the irrigation type, slope of the land, and incorporation of the manure. Generally, the setback distance must be longer the more inefficient the irrigation system is, the steeper the slope of the field, and the longer the time period before manure is incorporated.

Calibration of Manure Spreaders – Spreaders should be calibrated regularly so that the desired rate of manure is applied to the land. Calibration generally consists of determining the volume of the spreader, the weight of the manure in the spreader, and the spreading width and distance. Changes are made in tractor speed, PTO speed, apron setting, or other spreader settings in order to apply the desired amount of manure.

Concentrated Flow Areas – Grassed waterways can be used to trap sediments and thus filter out nutrients and organic matter. They also capture water through infiltration. Manure should not be applied on grassed waterways or in concentrated flow areas. Application setbacks also apply to concentrated flow areas.

Controlling Irrigation Erosion – Irrigation erosion occurs when large amounts of water are applied to erosive soils. Applied correctly, crop residues, conservation tillage practices, and polyacrylamides (PAM) can be used to reduce irrigation erosion.

Cover Type/Residues – Cover and surface roughness affects the amount of runoff that might occur during the period snow is melting, as well as the amount of erosion that might occur during runoff events. The greater the amount of cover and surface roughness the less erosion and runoff. Crops such as alfalfa, grass, or cover crops, surface residues, and plowed or rough bare ground lower the potential for surface runoff and erosion. Crop residues, for example, can reduce runoff and erosion by as much as fifty percent with only thirty percent cover.

Crop Rotation – Crops that capture and remove excess levels of nutrients should be used in the rotation and nutrient uptake values should be considered for different crops. For example, alfalfa that has just been plowed out will provide high levels of N. Manure should be applied at a rate that takes into consideration the high levels of N. Crops such as alfalfa can be used in the rotation to take up higher amounts of P if soil test P levels are high.

Incorporation – Manure should be incorporated in the soil as soon as possible after application to within at least a 4-inch depth. Manure that is not incorporated within one day after application will not only lose large amounts of N to volatilization but is more prone to runoff during a rainfall or irrigation event. Manure can be incorporated without runoff or leaching problems with injection equipment, tillage equipment or with sprinkler, or border irrigation systems.

Irrigation System Improvement – Flood systems generally have lower irrigation efficiencies than sprinkler systems. Uncontrolled flood systems often have efficiencies from 15 to 25% and have high amounts of runoff and deep percolation. Improved flood systems such as graded or level borders or sprinkler systems have efficiencies greater than 60%. System improvements may include practices such as land leveling, installing water control structures, reducing furrow length, piping ditches, and/or installing gated pipe or sprinkler systems.

Irrigation Water Management – Even though a system may be designed to operate efficiently, it can still be managed improperly. Other systems that are somewhat inefficient can be managed such that the irrigation efficiency is higher than it might be otherwise. Use of technology such as daily weather information, computer scheduling programs, dataloggers, tensiometers, refractometers, gypsum blocks, and soil augers can be used to help schedule irrigations at more appropriate intervals.

Managing Soil Moisture – Winter precipitation values vary greatly throughout Utah. In many cases, average winter precipitation is much less than the available water holding capacity of the soils. Soil moisture can be managed through irrigation and cropping practices. Growing the type of crops or managing them in such a manner as to not leave high soil moisture levels in the fall or not scheduling fall irrigations can provide additional capacity to store winter precipitation without allowing excess water to move through the soil profile in the spring.

Manure Application Rate – Where application rates exceed annual plant P and/or N needs, nitrogen can leach into the groundwater and phosphorus laden soil particles can erode. Phosphorus in solution can also be lost during runoff events. The amount of nutrients in the manure should be balanced with the plant needs. Supplemental fertilizers should be applied only as determined by a soil test.

Soil Limitations – Where a soil limitation is present at less than or equal to 2 feet in depth, manure should not be applied on frozen/snow covered ground. When applied during the spring, summer, or fall, manure should be applied at the agronomic rate for phosphorus.

Runoff Containment – When manure is applied on frozen and/or snow covered ground, the potential for runoff and leaching is increased due to spring runoff, particularly if the field is next to a water body or ditch. Berms or ditches can be built to contain or divert the runoff away from the waterbody or ditch into an area where water pollution will not occur. Manure should not be spread in the winter on areas where concentrated flow will carry the manure directly into a water body.

Slope – Manure applications on slopes greater than 5% should be avoided, or the rate should be applied according to crop P needs. Manure should also be incorporated as soon as possible after application.

Soil and Manure Testing – A soil test should be taken at least once every three years to monitor build-up or decline of STP levels. Take yearly soil tests for soil N levels when manure is to be applied on the basis of N. Manure tests should be taken a minimum of yearly for five years in order to develop average manure nutrient values for the management system. Manure tests should be taken separately for different types and consistencies (wet versus dry) of manure.

Tailwater Recovery Systems – Tailwater recovery systems are designed to capture irrigation runoff and either redirect the water to other fields or return it back to the head ditch. These systems may be as simple as building a ditch or distribution system to redistribute the water onto other fields or build ponds to capture the water and install pumps to return the water back to the head ditch.

Vegetative Buffers – Field borders, filter strips of small grains or perennial grasses, riparian forest buffers, and naturally vegetated stream banks are acceptable buffers, if they are the proper width and density, and are maintained properly. The appropriate NRCS practice standard should be used when designing vegetative buffers.

Wetland Systems **–** Wetlands aid in capturing and filtering nutrients, and may be natural or man made. Their location may be such that no water leaves the wetland (isolated) or such that water does leave (semi-isolated). Of course, wetlands that have water leaving them have a higher potential for pollution than those that don’t. Isolated wetlands fit into the **VERY LOW** risk category.

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